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FILTRATION-EXTRACTION:
A NEW PROCESS FOR RECOVERING OIL FROM OILSEEDS

A new, continuous process of solvent extraction of oilseeds has been successfully applied on a pilot-plant scale at the Southern Regional Research Laboratory. The heart of the process is a continuous, horizontal, vacuum filter—3.5 sq. ft. of filtering area—which has been operated at capacities up to 24 tons per day of cottonseed.

To date, 24 pilot-plant scale, experimental runs have been made, and more are scheduled. Three runs were on rice bran, 2 on soybean flakes, and the remainder on cottonseed. Detailed data on these runs are being reported in articles which will be presented during the next few months at technical meetings.

Use of the process permits:

Production of both oil and meal of high quality.

Lower solvent requirements, which should proportionately reduce solvent losses.

Lower solvent content of final meal and of final miscella (oil-solvent mixture), which should result in lower steam and recovery costs.

Low power consumption.

Lower installed cost of plants in comparison with existing processes, making the process particularly attractive to the smaller mills.

Possibility of complete mechanization and anticipation of low supervision and operating costs.

Use of conventional hydraulic or screw-pressing preparation operations without expensive modification.

How the filtration-extraction process works

The high capacities attained are dependent upon proper preparation and conditioning of the material fed to the filter. These operations require adequate rolling, moist cooking, and partial drying, which are followed by a granulating procedure to consolidate the fines into larger agglomerates. These combined operations promote oil extraction and facilitate the washing action of the filter.

The operation of the new, continuous process will be clear from a study of the flow-sheet, Figure 1.

The conditioned material is mixed with miscella (about 10% oil content) in a slurry mixing-conveyor, practically all of the oil going into solution, thus forming a concentrated miscella (about 30% oil content). The slurry is then deposited on the filter where the strong miscella is separated from the meal by countercurrent displacement washing, using commercial hexane. The action is too rapid to depend on leaching at this stage. During its stay on the filter the marc received three countercurrent washes which successively reduce the residual oil content of the final meal to 1% or lower. The extracted meal is discharged from the filter by means of a motor-driven scroll.

Equipment

The preparation and conditioning operations can be carried out in the conventional equipment used in hydraulic and screw-press mills, with only minor additions and slight modifications.

The slurry mixing-conveyor is simple in construction and of nominal cost. It provides a gentle agitation for 15 to 20 minutes. During this time practically all of the oil goes into solution.

The continuous horizontal rotary filter is of standard, commercial type, and requires only a solvent-tight sheet metal enclosure to prevent loss of solvent during its operation. Standard filter units having filtering areas of 10, 25, 65 and more square feet are available.

The miscella is evaporated and stripped for oil and solvent recovery and the solvent-damp meal dried for solvent recovery in standard equipment.

Material balances

In Table I are compared calculated material balances for the filtration-extraction process and for four commercial processes -- direct extraction, pre-press extraction, screw pressing, and hydraulic pressing. The balances are based on 100 tons per day of cottonseed of average composition. The percentage values shown are assumed but are believed to represent average commercial processing conditions.

Examination, especially, of lines 12, 14, 15, 20, and 21 in the table reveals some of the advantages and potentialities of the filtration-extraction process.

Continuing developments

In addition to continuing the experimental pilot-plant runs on various oilseeds, cost information obtained from equipment manufacturers is being assembled. It should present the anticipated costs for erecting filtration-extraction plants of small and large capacities and for converting existing hydraulic or screw pressing plants to filtration-extraction.

Safety

The solvent used in our research was commercial hexane which is the one used by practically all the solvent extraction mills processing soybeans and cottonseed. Since hexane is a flammable solvent, the possibilities for a fire or explosion must be recognized whether the plant is large or small, and all of the safety precautions recommended by the underwriters and the various safety codes should be followed. This should not pose any greater problem in the use of filtration extraction by small mills in view of the successful present-day use of other processes of solvent extraction on a much larger scale. The small mill operator will need to apply the same precautions as the larger mills do, and operating personnel will have to be trained with this in mind.

Arrangements can be made for inspecting and observing the pilot-plant operations at the Southern Regional Research Laboratory, and for discussing details of the process with appropriate technical personnel.

Attached is a list of selected publications of the Southern Regional Research Laboratory dealing with oilseed processing and solvent extraction applying mainly to cottonseed. Articles particularly pertinent to filtration-extraction are marked with the asterisk.

Further inquiries should be addressed to:

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Selected Publications of the Southern Regional Research Laboratory on Oilseed Processing

The Cottonseed Industry and the Southern Laboratory. Edward A. Gastrock and Klare S. Markley. Oil Mill Gazetteer 44, No. 12, 29-31 (1940).

Technology of the Cottonseed Crushing Industry. K. S. Markley and D. F. J. Lynch. Cotton Research Congr., Proc. (Waco, Texas) 1, 211-24 (1940). Also, processed. ACE-63 (1940).

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U. S. Manufacturers and Suppliers of Equipment for Processing Cottonseed and Peanuts into Oils, Meal and Byproducts. Processed. AIC-98 (revised), (1947).

Solvent Extraction of Cottonseed and Peanut Oils. I. Boiling Point-Vapor Pressure-Composition Relations for Miscellas of Oils in Hexane. E. F. Pollard, H. L. E. Vix, and E. A. Gastrock. Ind. Eng. Chem. 37, 1022-26 (1945).

Solvent Extraction of Cottonseed and Peanut Oils. II. Effect of Heat on Cottonseed Oil Miscellas. H. L. E. Vix, E. F. Pollard, J. J. Spadaro, and E. A. Gastrock. Ind. Eng. Chem. 38, 635-42 (1946).

Solvent Extraction of Cottonseed and Peanut Oils. III. The Effect of Heat on Cottonseed Oil in Miscellas from Uncooked and Cooked Flaked Meats. E. L. D'Aquin, J. J. Spadaro, H. L. E. Vix, J. Pominski, L. J. Molaison and E. F. Pollard. Oil Mill Gazetteer 51, No. 10, 17-19 (1947).

Solvent Extraction of Cottonseed and Peanut Oils. IV. Pilot Plant Batch Extractions. J. Pominski, L. J. Molaison, A. J. Crovetto, R. D. Westbrook, E. L. D'Aquin, and W. F. Guilbeau. Oil Mill Gazetteer 51, No. 12, 33-9 (1947).

Continuous Solvent Extraction at the Southern Regional Research Laboratory. E. A. Gastrock and E. L. D'Aquin. Oil Mill Gazetteer 55, No. 4, 13-21 (1948).

Solvent Extraction of Cottonseed and Peanut Oils. VII. Effect of Flake Drying on Color of Cottonseed Oil and Meal Properties. J. J. Spadaro, E. J. McCourtney, and H. L. E. Vix. J. Am. Oil Chem. Soc. 27, 394-96 (1950).

Solvent Extraction of Cottonseed and Peanut Oils. VIII. Effects of Moisture on the Preparation and Flaking of Cottonseed. C. G. Reuther, R. D. Westbrook, H. L. E. Vix, and E. A. Gastrock. J. Am. Oil Chem. Soc. 28, 146-49 (1951).

Solvent Extraction of Cottonseed and Peanut Oils. IX. Determination of Fines in Miscella. A. V. Graci, Jr., A. J. Crovetto, J. S. Parker, and C. G. Reuther. J. Am. Oil Chem. Soc. 29 (2), 71-3 (1952).

Pre-Pilot Plant Mixed Solvent Flotation Process for Separating Pigment Glands from Cottonseed Meats. H. L. E. Vix, J. J. Spadaro, R. D. Westbrook, A. J. Crovetto, E. F. Pollard, and E. A. Gastrock. J. Am. Oil Chem. Soc. 24, 228-36 (1947); AIC-164.

Pilot-Plant Fractionation of Cottonseed. I. Disintegration of Cottonseed Meats. J. J. Spadaro, R. M. Persell, C. H. Murphy, Jr., H. L. E. Vix, E. J. McCourtney, J. Hecker, E. F. Pollard, and E. A. Gastrock. J. Am. Oil Chem. Soc. 25, 345-53 (1948).

Pilot-Plant Fractionation of Cottonseed. II. Differential Settling. H. L. E. Vix, J. J. Spadaro, C. H. Murphey, Jr., R. M. Persell, E. F. Pollard, and E. A. Gastrock. J. Am. Oil Chem. Soc. 26, 526-30 (1949).

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Process for the Fractionation of Cottonseed. H. L. E. Vix, C. H. Murphey, J. J. Spadaro, Elisha F. Pollard, E. A. Gastrock, and R. M. Persell. U. S. Patent No. 2,579,526. Dec. 25, 1951.

Boiling Points of Cottonseed and Peanut Oil Miscellas in English Units. K. M. Decossas, H. A. Mackey, and G. P. Heughan. Processed. AIC-257 (1950).

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*Pre-Pilot Plant Investigation of a Solvent Extraction Method for Cottonseed Based on Reduced Pressure Filtration. J. J. Spadaro, A. V. Graci, H. K. Gardner, Jr., J. S. Parker, E. J. Laborde, and E. A. Gastrock. Oil Mill Gazetteer 56, No. 1, 77-81 (1951).

*Recent Technological Advances in Cottonseed Processing. E. A. Gastrock. Oil Mill Gazetteer 56, No. 1, 35-37 (1951).

NOT FOR PUBLICATION

Table I

100 T/D COTTONSEED PROCESSING PLANT

Material Balances for Five Processes

	Direct Extraction	Filtration Extraction	Pre-Press Extraction	Screw Pressing	Hydraulic Pressing
1. Cottonseed 1/ (18.6% oil, 3.76% NH_3)	200,000	200,000	200,000	200,000	200,000
2. Linters 1/ (0.61% oil)	19,000	19,000	19,000	19,000	19,000
3. Loss 1/	12,230	12,230	12,230	12,230	12,230
4. Hulls 1/ (0.53% oil)	44,420	44,420	44,160	47,340	48,400
5. Meats Fraction	124,350	124,350	124,610	121,430	120,370
6. Oil in Meats	36,830	36,830	36,830	36,830	36,830
7. Oil Recovered by Pressing	---	---	27,080	33,030	31,970
8. Press Cake	---	---	97,530	88,400	88,400
9. Oil in Press Cake	---	---	10%-9,750	4.3%-3,800	5.5%-4,860
10. Final Meal	88,400	88,400	88,400	88,400	88,400
11. Oil in Final Meal	1.0%-880	1.0%-880	0.7%-620	4.3%-3,800	5.5%-4,860
12. Solvent in Marc	50%-88,400	25%-29,470	40%-58,930	---	---
13. Oil Extracted	35,950	35,950	9,130	---	---
14. Total Oil Recovered	35,950	35,950	36,210	33,030	31,970
15. Miscella to Evaporator	20%-179,750	32%-112,340	20%-45,650	---	---
16. Miscella to Stripper	90%-39,940	90%-39,940	90%-10,140	---	---
17. Solvent from Evaporator	139,810	72,400	35,510	---	---
18. Solvent from Stripper	3,990	3,990	1,010	---	---
19. Total Solvent in Miscella	143,800	76,390	36,520	---	---
20. Total Solvent	232,200	105,860	95,450	---	---
21. Solvent-Meal Ratio	1.87/1.00	0.85/1.00	0.77/1.00		

1/ Source: Agricultural Information Bulletin No. 39, PMA, USDA, May 1951.

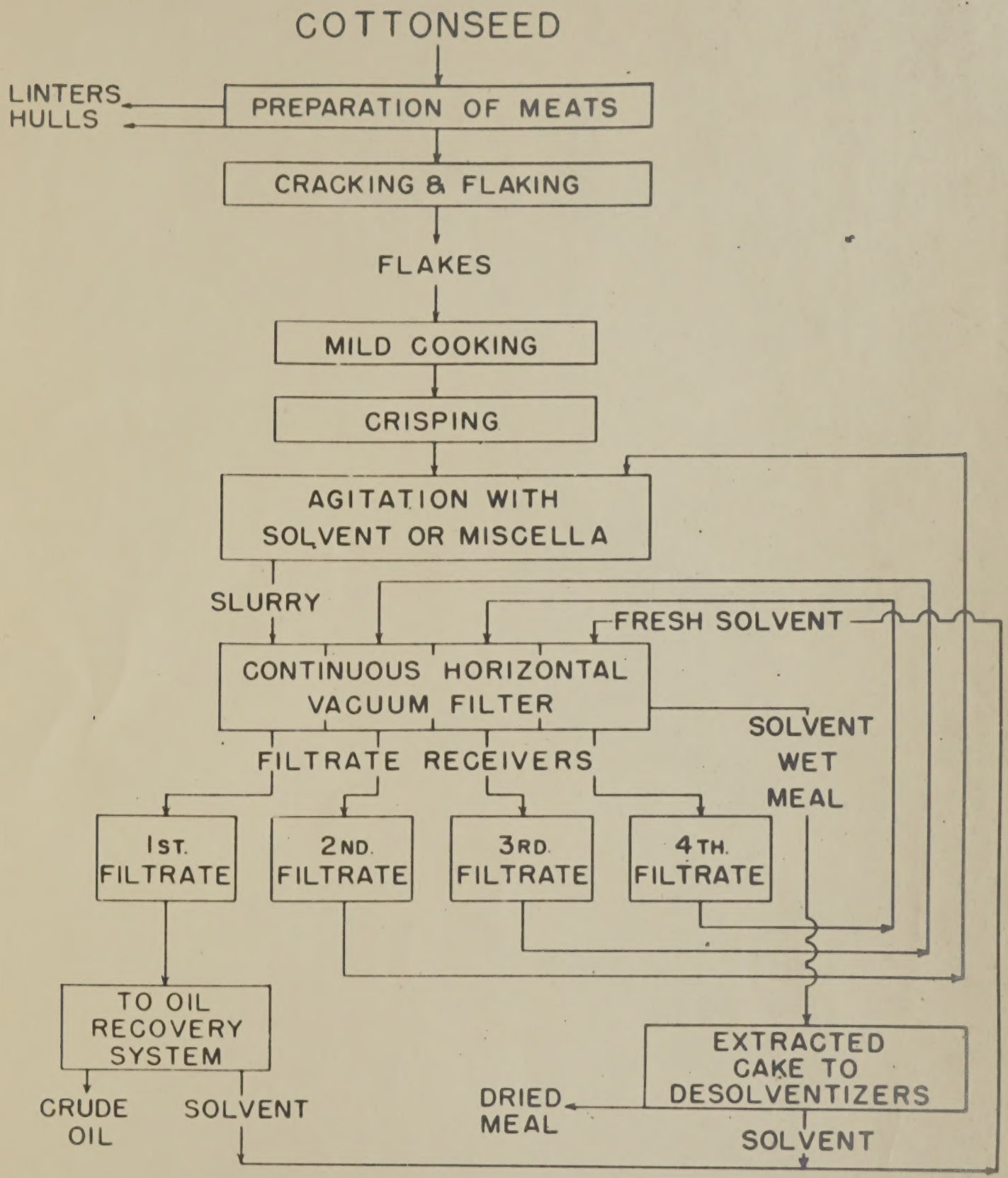
COTTONSEED
LINTERS
HULLS
PREPARATION OF MEATS
CRACKING & FLAKING
FLAKES
MILD COOKING
CRISPING
AGITATION WITH SOLVENT OR MISCELLA
SLURRY
FRESH SOLVENT
CONTINUOUS HORIZONTAL VACUUM FILTER
SOLVENT WET MEAL
FILTRATE RECEIVERS
1ST. FILTRATE
2ND. FILTRATE
3RD. FILTRATE
4TH. FILTRATE
TO OIL RECOVERY SYSTEM
CRUDE OIL
SOLVENT
EXTRACTED CAKE TO DESOLVENTIZERS
DRIED MEAL
SOLVENT

FIGURE I